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In order that u may be a maximum, we have, differentiating the last four equations, putting $du=0$, and using the method of indeterminate multipliers,

$$\frac{\lambda_1 x_1}{a^2}+y_4-y_2=0,\quad \frac{\lambda_1 y_1}{b^2}-x_4+x_2=0.$$

. . . . . .

Hence we have $\frac{x_1}{a^2}(x_4-x_2)=-\frac{y_1}{b^2}(y_4-y_2)$....(1),

$$\frac{x_2}{a^2}(x_1-x_3)=-\frac{y_2}{b^2}(y_1-y_3)....(2),\quad \frac{x_3}{a^2}(x_2-x_4)=-\frac{y_3}{b^2}(y_1-y_4)....(3),$$

$$\frac{x_4}{a^2}(x_3-x_1)=-\frac{y_4}{b^2}(y_3-y_1)....(4).$$

From (1) and (3) we have $\frac{y_3}{x_3}=\frac{y_1}{x_1}$....(5), and from (2) and (4), $\frac{y_4}{x_4}=\frac{y_2}{x_2}$....(6). Also from (1) and (2), $\frac{1}{a^2}(x_1x_4-x_2x_3)=-\frac{1}{b^2}(y_1y_4-y_2y_3)$.

From the last three equations we see that

$$\frac{1}{a^2}(x_1x_4-x_2x_3)=-\frac{1}{b^2}y_1y_2\left[\frac{x_4}{x_2}-\frac{x_3}{x_1}\right],\text{ and therefore }\frac{y_1y_2}{x_1x_2}=-\frac{b^2}{a^2}..(7).$$

The equations (5) and (6) show that the diagonals of the quadrilaterals are diameters of the ellipse, and (7) shows that they are conjugate diameters.

Also solved by *G. B. M. ZERR*, *A. H. HOLMES*, and *L. C. WALKER*.

130. Proposed by J. SCHEFFER. A. M., Hagerstown, Md.

Solve the differential equation $x^x(\frac{dy}{dx}+y\log x)-a=0$.

I. Solution by W. E. HEAL, Marion, Ind.

Writing the equation $\frac{dy}{dx}+y\log x=a/x^x$, we have a linear equation of the standard form, and by the well known formula, $y=-Ca/x^x$.

II. Solution by C. HORNUNG, A. M., Professor of Mathematics, Heidelberg University, Tiffin, Ohio.

Dividing by x^x and transposing we get $dy/dx+\log x.y=ax^{-x}$, the regular form of the *linear* equation.

Using Bernoulli's method, we proceed as follows:

Let $y=uz$; then $dy/dx=u\frac{dz}{dx}+z\frac{du}{dx}$, and the given equation becomes

$$u\frac{dz}{dx}+z(\frac{du}{dx}+u\log x)=ax^{-x}.$$

Now, if the function u be assumed of such value as to make the factor z in this equation vanish, we shall have the two equations,

$$\frac{du}{dx}+u\log x=0, \text{ and } u\frac{dz}{dx}=ax^{-x}.$$

From the former, we get by integration, $u=e^xx^{-z}$, and the value of u reduces the latter to $e^x\frac{dz}{dx}=a$ or $dz=ae^{-x}dx$. Whence $z=-ae^{-x}+C$.

Therefore $y=uz=e^xx^{-x}(-ae^{-x}+C)=x^{-x}(Ce^x-a)$, which is the required solution.

Also solved by *L. C WALKER*, *G. B. M. ZERR*, *F. P. MATZ*, and *J. SCHEFFER*.

131. Proposed by F P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.

Integrate $2/x$, with regard to $d[\sqrt{(1-x^2)}]$.

Solution by the PROPOSER.

According to the conditions of the problem, we may write $d[F(x)]/d[\sqrt{(1-x^2)}]=2/x....(1)$.

$$\therefore F(x)=2\int\frac{d[\sqrt{(1-x^2)}]}{x}=-2\int\frac{dx}{\sqrt{(1-x^2)}}=\sec^{-1}\left[\frac{1}{2x^2-1}\right]$$

$=\cos^{-1}(2x^2-1)....(2)$, which is the integral required.

Also solved with various results by *H. C. WHITAKER*, *J. SCHEFFER*, and *G. B. M. ZERR*.

132. Proposed by JOHN M. COLAW, A. M., Monterey, Va.

What expression derived from the *polar* equation of a curve is equivalent to the expression for dy/dx derived from the *Cartesian* equation of the same curve? Prove work with $\rho=2r\cos\theta$.

Solution by LON C. WALKER, A.M., Professor of Mathematics, Petaluma High School, Petaluma, Cal.

Let $x=\rho\cos\theta$, $y=\rho\sin\theta$, then

$$\frac{dy}{dx}=\frac{\sin\theta(d\rho/d\theta)+\rho\cos\theta}{\cos\theta(d\rho/d\theta)-\rho\sin\theta}....(1).$$

From $\rho=2r\cos\theta$, we get $d\rho/d\theta=-2r\sin\theta$. Substituting this value of $d\rho/d\theta$ in (1), and reducing, we have

$$\frac{dy}{dx}=\frac{r-x}{y}....(2).$$

Now substituting the value of x and y in $\rho=2r\cos\theta$, we get $x^2+y^2=2rx$; from which $dy/dx=(r-x)/y$, the same as in (2).